Instrument for Simultaneous Assessment of Fluorescein and Thermal Dynamics of the Tear Film

Henry Kricancic, Hamish McNeill, Michael Titze, David Alonso-Caneiro, and Michael J. Collins

Contact Lens and Visual Optics Laboratory, Queensland University of Technology, Brisbane, Australia (h.kricancic@qut.edu.au)

BACKGROUND

- Ocular thermography has been identified as a potential technique for non-invasive assessment of various tear-film disorders, particularly dry eye [1].
- Using infrared thermal imaging, past studies have shown that changes in ocular surface temperature (OST) are associated with tear-film break-ups [2].
- Contact lens wear is associated with warming of the tear-film [3], however this mechanism is not fully understood.
- In this study we developed and tested a custom-built instrument for simultaneous assessment of fluorescein and thermal changes associated with tear film dynamics during contact lens wear.

METHODS

- Tear-film dynamics of four subjects were assessed during soft hydrogel contact lens wear, under suppressed blinking conditions (30s duration, no blinking).
- The custom built instrument combines an infrared thermal camera (FLIR A655sc) with a visible camera, which simultaneously recorded OST and fluorescein break-up.
- A germanium filter allowed transmission of thermal signals to the infrared camera while reflecting fluorescein luminescence to the visible camera.
- All components were secured together using a custom 3D-printed model (Fig. 1).
- Fluorescein break-up was visualised using blue LED lights (dominant wavelength 470 nm) and a Wratten filter (500 nm).
- In this study, thermal and fluorescein signal dynamics were quantified as the mean value for the entire anterior surface of subjects' eyes (i.e. corneal and scleral regions).

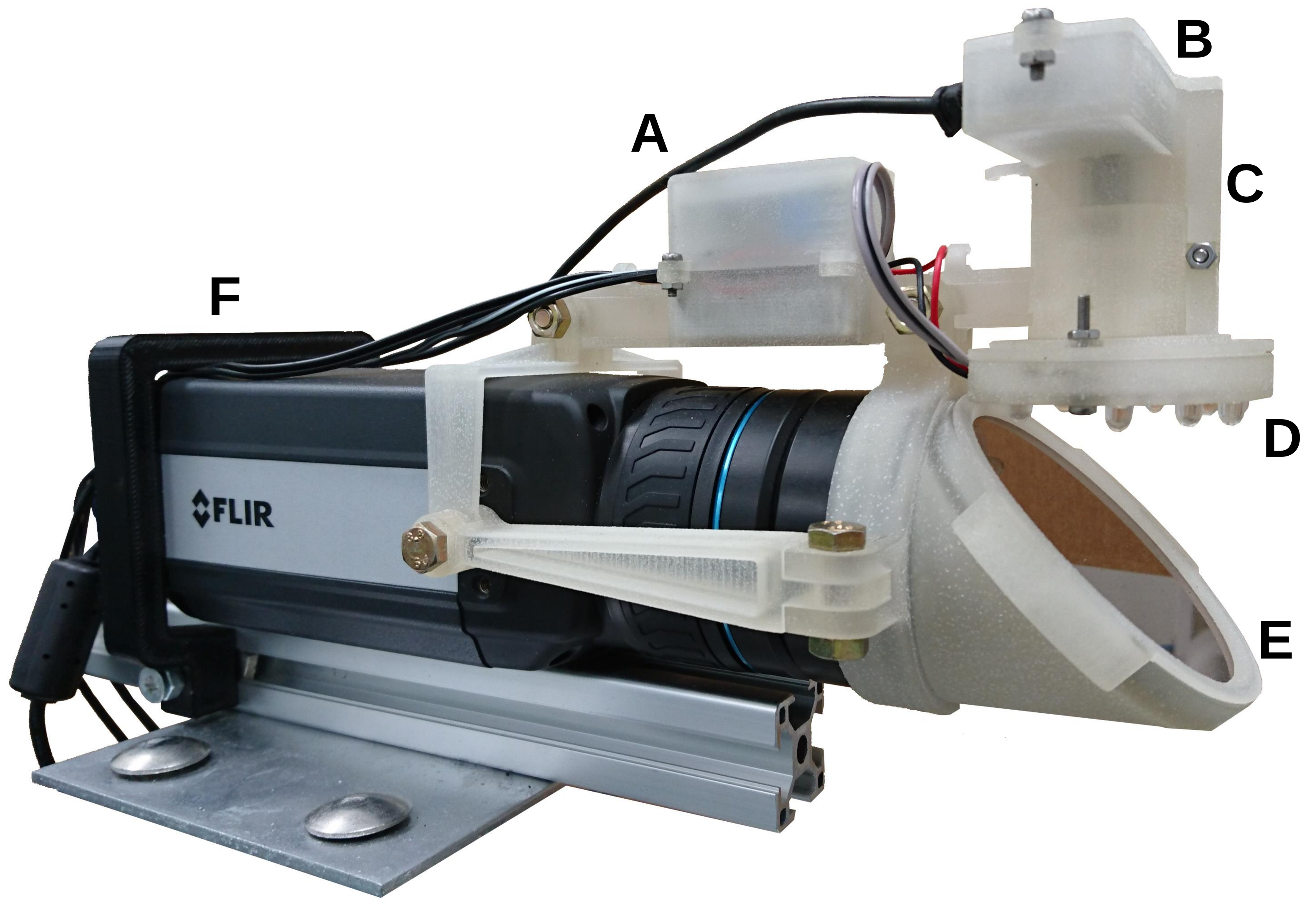

Fig. 1 Components were secured together using a custom 3D-printed model. (A) LED circuitry, (B) visible camera, (C) Wratten filter, (D) blue LED lights, (E) germanium filter, (F) thermal camera.

RESULTS

- There was a strong statistically significant correlation between mean fluorescein intensity and mean OST dynamics (mean Pearson's $r = 0.81$, range 0.61 to 0.94, $p < 0.05$).
- A typical recording shows strongly correlated signal dynamics (Fig. 2 (top, middle left)).
- It was observed that mean OST changes sometimes occurred earlier than the fluorescein break-up (Fig. 2 (middle right, bottom)).

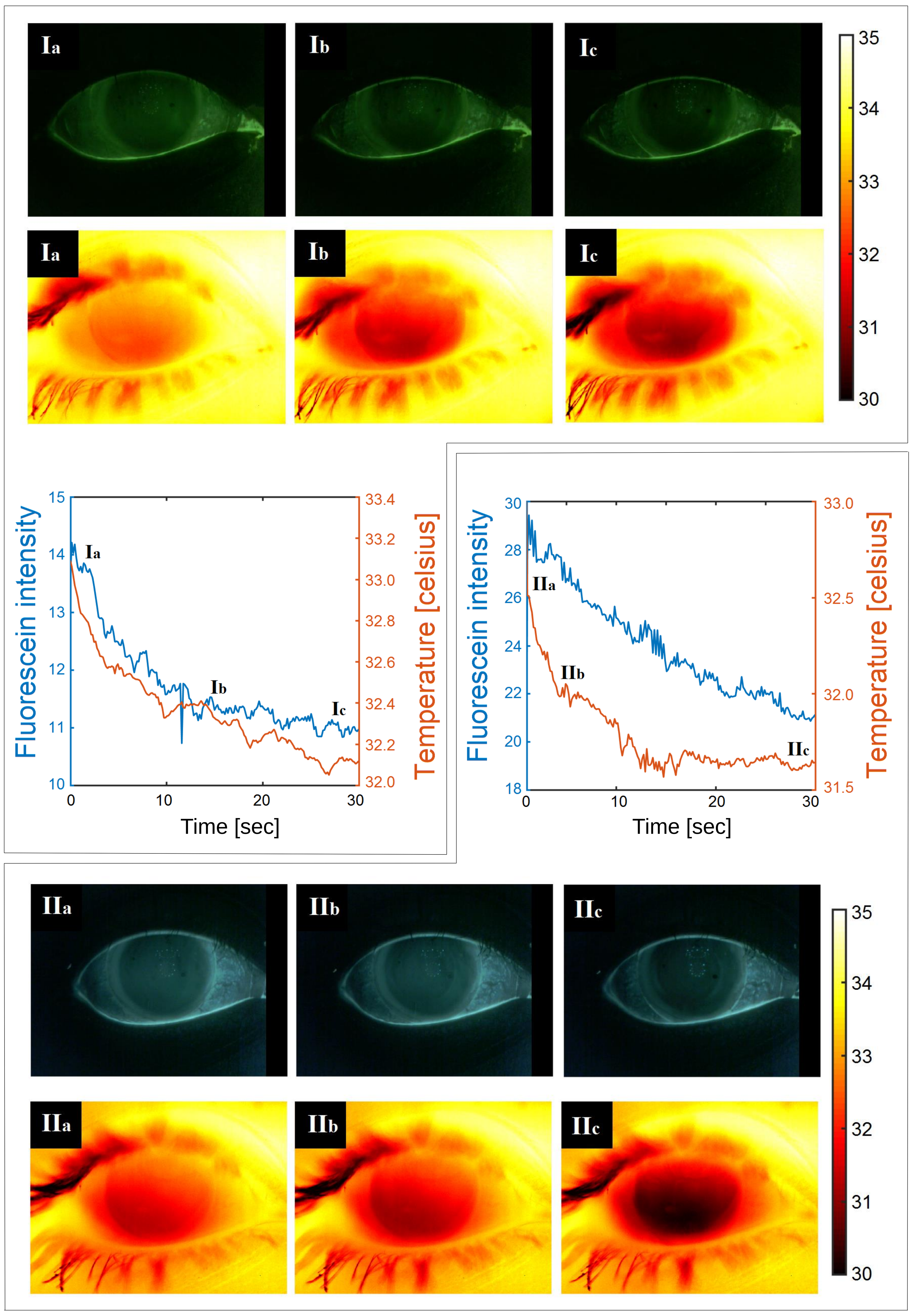

Fig. 2 Two representative examples that show the estimated temperature and fluorescein intensity change during suppressed blinking. Top and middle left panels show a good correlation between thermal and fluorescein signal, as well as images with a good (Ia) and poor (Ic) tear film. Middle right and bottom panels show different signal dynamics, with thermal signal showing earlier signs of change (IIb) than the fluorescein intensity.

CONCLUSIONS

- An instrument and software to simultaneously record and analyse fluorescein and thermal signal dynamics was developed and evaluated.
- Results showed strong correlation between mean OST and mean fluorescein intensity dynamics over time, which is in agreement with previous studies.
- This method may contribute to our understanding of the influence of contact lens wear upon tear film stability.

REFERENCES

[1] P. B. Morgan, M. P. Soh, N. Efron, and A. B. Tullo, "Potential applications of ocular thermography," *Optometry & Vision Science,* vol. 70, pp. 568-576, 1993.

[2] T.-Y. Su, S.-W. Chang, C.-J. Yang, and H. K. Chiang, "Direct observation and validation of fluorescein tear film break-up patterns by using a dual thermal-fluorescent imaging system," *Biomedical Optics Express,* vol. 5, pp. 2614-2619, 2014.

[3] C. Purslow, J. S. Wolffsohn, and J. Santodomingo-Rubido, "The effect of contact lens wear on dynamic ocular surface temperature," *Contact Lens and Anterior Eye,* vol. 28, pp. 29-36, 2005.